High-Pressure Slurry Ablation (HPSA): Review of Findings, Potential Applications, and Future Developments

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Abstract

Disa Technologies Inc. provides innovative, sustainable solutions for mineral processing and remediation through its patented High-Pressure Slurry Ablation (HPSA) technology. HPSA processes solid feed material in slurry form, propelled by high pressure pumps through opposing nozzles that generate impinging jets within a collision housing. This process induces particle-to-particle collisions in a high energy zone, creating intergranular fractures along grain boundaries. In our batch scale and continuous operating testing, we have found that controlling key processing variables such as nozzle velocity, slurry solids percentage, and the number of passes can allow for controlled size reduction and maximum mineral liberation.

Since 2018, Disa Technologies has demonstrated the versatility of HPSA by testing it on diverse materials, including phosphate, copper, uranium, vanadium, zinc, rare earth elements, lithium, nickel, mineral sands, gold tailings, and more. The intent of this paper is to present an overview of our test results describing in detail impacts on size reduction, recovery, and grade with a focus on HPSA's adaptability across ore types. Looking forward, it explores the potential to process materials such as DR-grade iron, clay, PGMs, bauxite, and various tailings. Additionally, it examines planned advancements in HPSA technology, including optimized nozzle spacing, higher capacity models, improved tonnage-to-footprint ratios, enhanced maintenance features, and expanded nozzle configurations.

Introduction

In an era where sustainability and efficiency are paramount, the mining and mineral processing industries face growing pressure to adopt technologies that enhance resource recovery while minimizing environmental impact. HPSA offers a practical, field-tested approach to overcoming both energy and environmental hurdles in mineral processing. This innovative technology harnesses high pressure jets of slurry to induce intense particle collisions, enabling selective liberation of valuable minerals and contaminants without needing energy-intensive grinding media or chemical treatments. By operating at high pressures, HPSA achieves efficient material disintegration and separation, paving the way for cleaner, more cost-effective mineral processing and environmental remediation.

During our testing in USA phosphate and rare earth operations we saw firsthand how HPSA outperformed conventional grinding equipment. From improving the recovery of critical minerals to remediating mine tailings, contaminated sites, and optimizing industrial water treatment processes, HPSA offers unparalleled potential.

This paper summaries our lab and field based testing of HPSA technology and evaluates how it performed across a range of ore types and processing conditions. Key areas of focus include its impact on critical minerals such as uranium, copper, phosphate, graphite, and rare earth elements. By examining case studies and testing results, this paper illustrates the capability of HPSA to revolutionize mineral processing and environmental remediation, offering insights into its scalability and future potential in industrial applications.

HPSA Technology Overview

HPSA is an innovative technology designed to enhance mineral processing and environmental remediation. It utilizes high-pressure slurry jets to create intense collisions between particles, effectively stripping unwanted materials from valuable minerals or contaminants from waste. The process operates at high pressures, enabling efficient disintegration and separation of materials without the need for expensive and wasteful grinding media or extensive chemical treatments. Since beginning testing in 2018 we've consistently observed the technologies' ability to liberate targeted materials at coarser particle sizes, reducing energy consumption and operational costs while minimizing waste generation.

Image 1: HPSA Collision Chamber

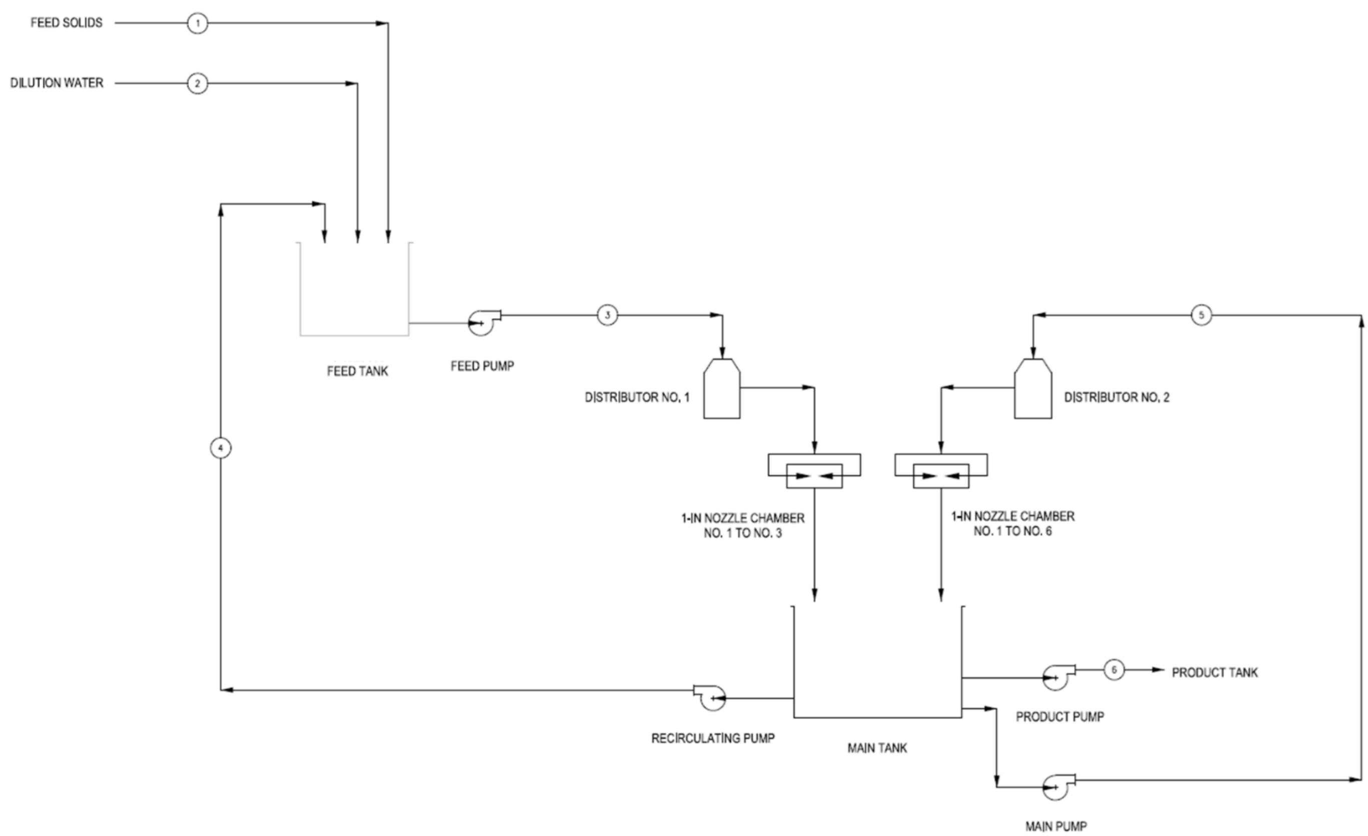


Image 2: HPSA Material Flow

HPSA technology has versatile applications, including:

1. **Mineral Processing**: It improves the recovery and extraction of critical minerals by efficiently liberating them from surrounding materials.

2. **Environmental Remediation**: HPSA is a promising solution for cleaning up contaminated sites, such as legacy mine waste or areas polluted with radionuclides and heavy metals. It helps remove harmful substances while minimizing environmental impact.

3. **Water Treatment**: The technology can regenerate filter sand media and optimize filtration processes in industrial water treatment facilities.

Research and development efforts are focused on scaling up HPSA technology for industrial use, improving energy efficiency, and expanding its applicability. Its potential to reduce the environmental footprint of mining and waste management, along with its ability to liberate at coarser sizes, makes it a strong candidate for operations looking to cut energy costs and reduce environmental impact.

Testing Results

Uranium

High-Pressure Slurry Ablation (HPSA) technology has been extensively evaluated for its ability to selectively liberate target minerals from various uranium ore types, demonstrating significant potential to enhance mineral processing efficiency. A study focusing on uranium-bearing sandstone formations, commonly found at Abandoned Uranium Mine (AUM) sites on the Navajo Nation, showcased HPSA's effectiveness in isolating contaminants such as uranium. By leveraging controlled slurry stream collisions, the process disassociates composite particles into discrete subfractions, concentrating over 90% of uranium into the -37 micron size fraction, which accounts for only 17% of the processed material's total mass. This remarkable mass reduction highlights HPSA's ability to minimize waste volumes requiring offsite disposal while maximizing resource recovery efficiency.

The results also emphasized the importance of carbon removal in recovering uranium from coarser particle size fractions. Carbon particles, common in sandstone formations, were identified as significant contributors to residual uranium concentrations in fractions above 37 microns. Simple size separation following HPSA processing proved effective in reducing uranium concentrations in these coarser fractions, lowering levels from over 990 ppm to below 3 ppm. This underscore HPSA's applicability as a cost-effective and energy-efficient alternative to conventional comminution techniques, aligning with industry goals for sustainable and precise mineral processing solutions (1).

Another study demonstrated HPSA's versatility in processing milling and leaching materials, achieving particle size reduction from 280 μm to 160 μm (2). The technology selectively liberated uranium-bearing phases while rejecting harder gangue minerals like quartz, further reducing reagent consumption and enhancing recovery potential.

Phosphate

HPSA technology was evaluated as a particle attrition process to enhance mineral liberation and reduce phosphate ore particle size. Testing focused on raw shale feed and classifier overflow material to improve liberation efficiency and impurity removal. HPSA effectively separated phosphate-bearing apatite from gangue minerals through surface cleaning and grain boundary fractures while reducing feed size from approximately 2.3 mm to 580 μm (2). The process increased the recovery of acid-consuming minerals (CaO, MgO) and insolubles (SiO_2, Al_2O_3, Fe_2O_3) in the reject fraction, with up to 40% and 17% increases (2), respectively. HPSA outperformed conventional rod mills in improving P_2O_5 grade and impurity separation, improving grade by over 4% and increasing recovery by 3% (2).

In another on-site trial within a phosphate scavenger circuit HPSA demonstrated significant improvements in mineral recovery and impurity reduction compared to conventional processing methods. P_2O_5 significantly outperformed the traditional ball mill increasing recovery by over 20% (2). In our analysis, improved P_2O_5 recoveries were largely tied to better grain-boundary breakage between the apatite and gangue minerals. Additionally, HPSA reduced MgO content by over 50% (2), efficiently separating acid-consuming minerals into the fine reject fraction (-325 mesh), thereby improving downstream processing efficiency. Controlled liberation through particle-to-particle collisions allowed us to improve apatite separation while minimizing overgrinding, a known issue in typical grinding applications.

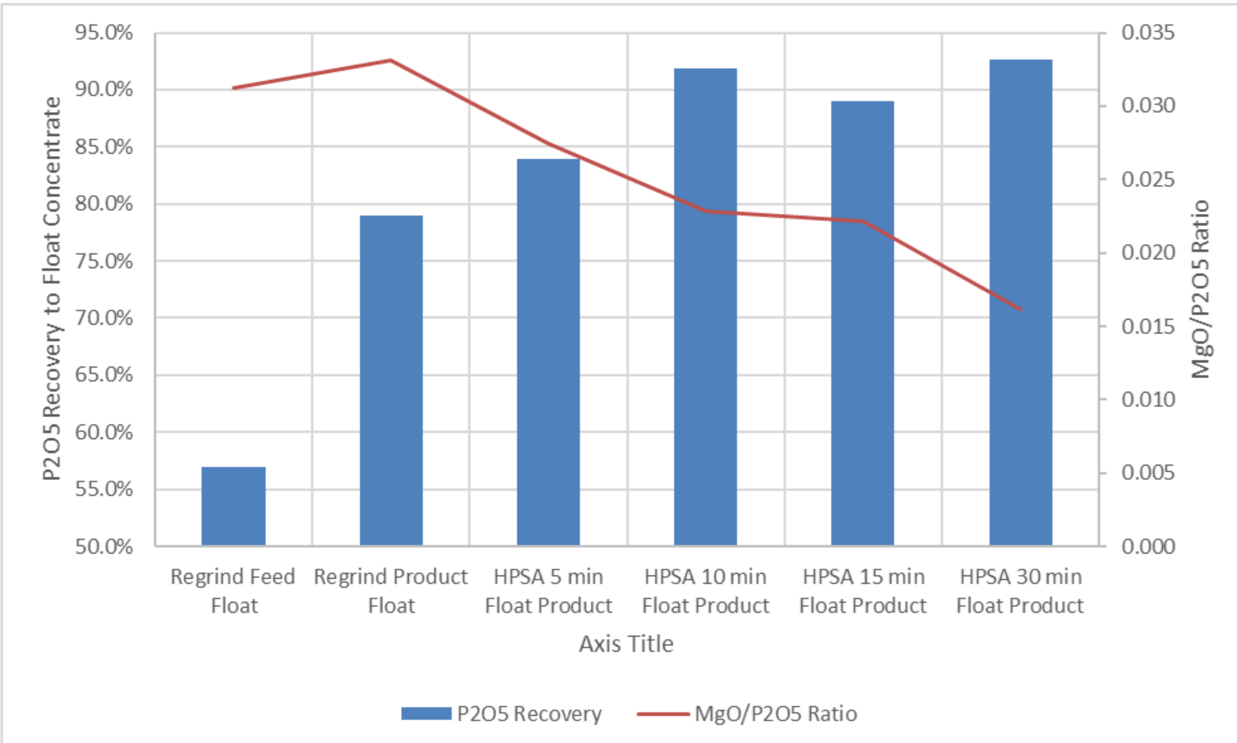


Chart 1: P_20_5 Recovery and MgO/ P_20_5 Ratio (2)

Graphite

We have tested four different graphite ores, and all tests showed significant potential as a superior method for graphite ore processing with better liberation and higher concentrate grades compared to conventional grinding methods such as ball and rod mills. For example, in one trial, HPSA increased graphite concentrate grades by over 50% (2) without compromising recovery, which surpasses grades typically seen in a traditional grinding circuit. By increasing grade up-front we were able to remove some downstream cleaning stages.

At one of our test programs with Canadian graphite ore, HPSA achieved similar recoveries to a rod mill but with fewer concentration steps, indicating potential for streamlined processing. Another project demonstrated HPSA's ability to produce a concentrate grade of 90%, a 16% improvement over a ball mill, while maintaining comparable recoveries (2). A third project showed the technology was able to achieve up to a 28% improvement in graphite grade and 1% increase in recovery when compared to conventional milling methods (2), with the potential to significantly reduce the operational and capital expenditures of flotation systems.

The advantages of HPSA extend beyond performance metrics. Its ability to improve graphite liberation increases the efficiency of flotation processes, while its low maintenance requirements and elimination of consumables, such as grinding media, contribute to lower operational costs.

HPSA simplifies downstream circuits by reducing the mass sent for further processing and eliminates multiple cleaning stages.

Lithium

HPSA technology was evaluated as an alternative to conventional ball milling for lithium ore processing. Comparative tests demonstrated that HPSA effectively reduces particle size while generating fewer fines, thereby improving the liberation of lithium-bearing minerals. Unlike ball mills, HPSA achieves coarser liberation (see Chart 2) which can optimize downstream processes such as flotation. HPSA can also help address recovery challenges caused by high percentage of fines created by High Pressure Grinding Rolls (HPGR) and provide alternative circuits to mitigate this issue. The tests also revealed that HPSA concentrated more lithium into fine fractions (<53 µm) without compromising grade, highlighting its potential to outperform ball milling in liberation efficiency and recovery. Furthermore, Heavy Liquid Separation (HLS) tests indicated that even at the coarser size fraction the recovery increased by nearly 20%, showing the technology could transform regrind applications in spodumene circuits (2).

In a separate evaluation, HPSA demonstrated 5% higher spodumene liberation with over 80% free surface area at the target grind size of 150 µm compared to conventional ball milling (2). Particle size distribution analysis showed HPSA produces a more uniform and coarser grind, enhancing downstream processing. While this study was conducted in batch settings, the results are promising enough for potential incorporation into greenfield projects already.

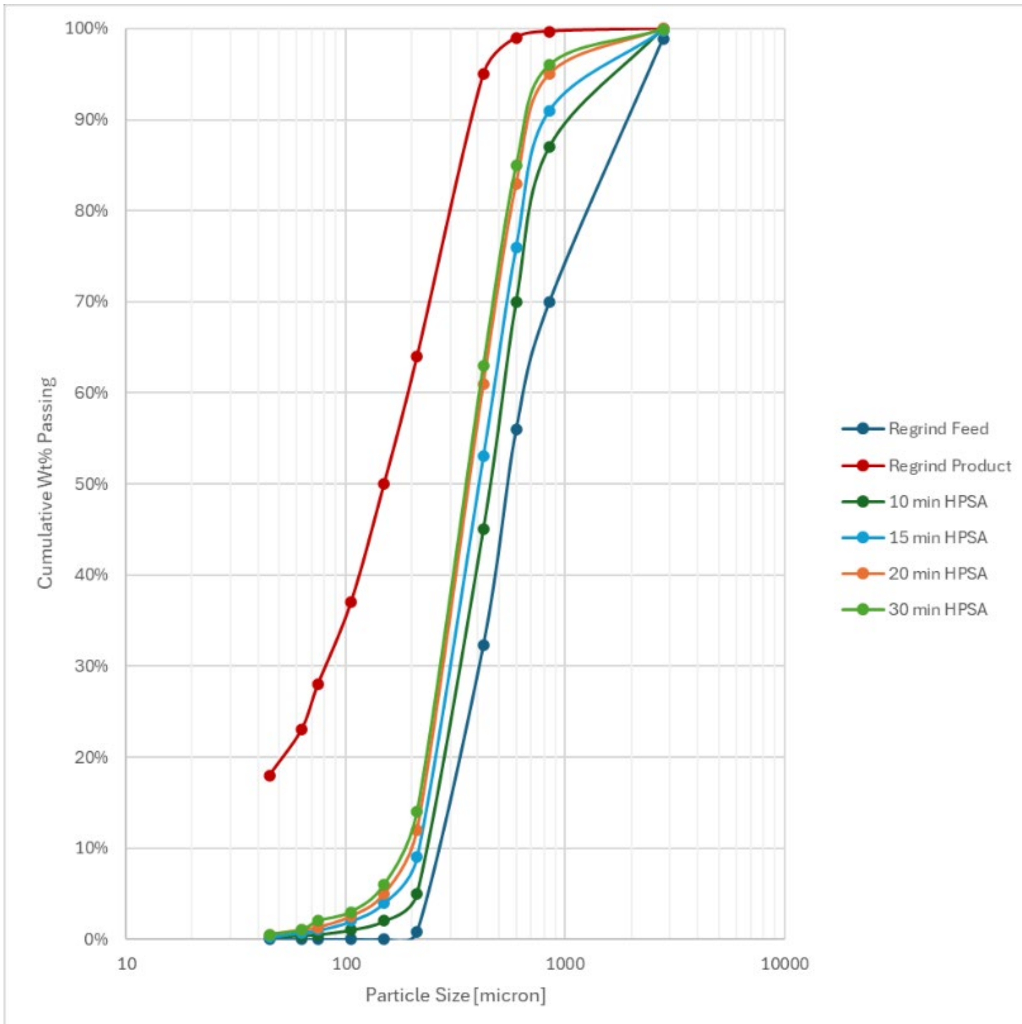


Chart 2 – Ball mill versus HPSA Lithium Ore PSD Comparison (2)

Sample	**HLS - Distribution to +3.0 SG (>6% Li2)**			
	+1,000 µm	**-1,000 +500 µm**	**-500 +20 µm**	**All**
Regrind Product	2.8	36	37	76
10 min HPSA	2.5	38	54	95
20 min HPSA	30	64	95	95

Table 1: Lithium Recovery Comparison HPSA versus Ball Mill (2)

<u>Rare Earth</u>

HPSA testing across multiple rare earth element (REE)-bearing materials demonstrated its effectiveness in reducing particle sizes, liberating minerals, and increasing REE concentration. The HPSA process successfully reduced feed material to finer fractions (e.g., -149 µm or finer), improving the exposure and separability of REE-bearing minerals such as allanite and bastnaesite (2). In our REE testing, the recoveries ranged from 75% to over 85%, outperforming traditional grinding methods like ball milling (2). Elemental analysis confirmed significant REE enrichment in finer fractions post-HPSA, with concentrations increasing by up to 51% compared to baseline feed distributions (see Chart 3 & 4 below)(2). Subsequent magnetic and flotation separation tests further increased REE recovery, achieving recoveries up to 66.5% and grade improvements of 1.5% in flotation (2).

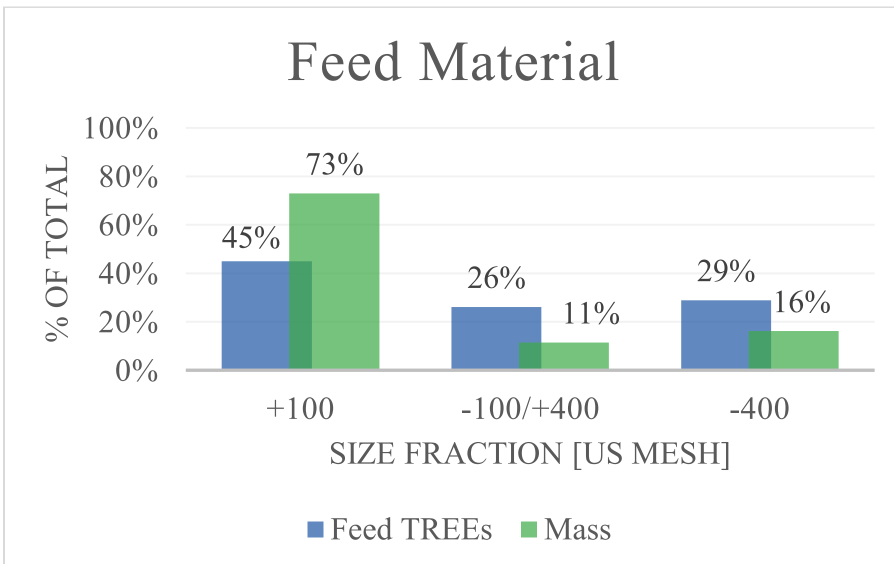


Chart 3: HPSA REE Feed Material (2)

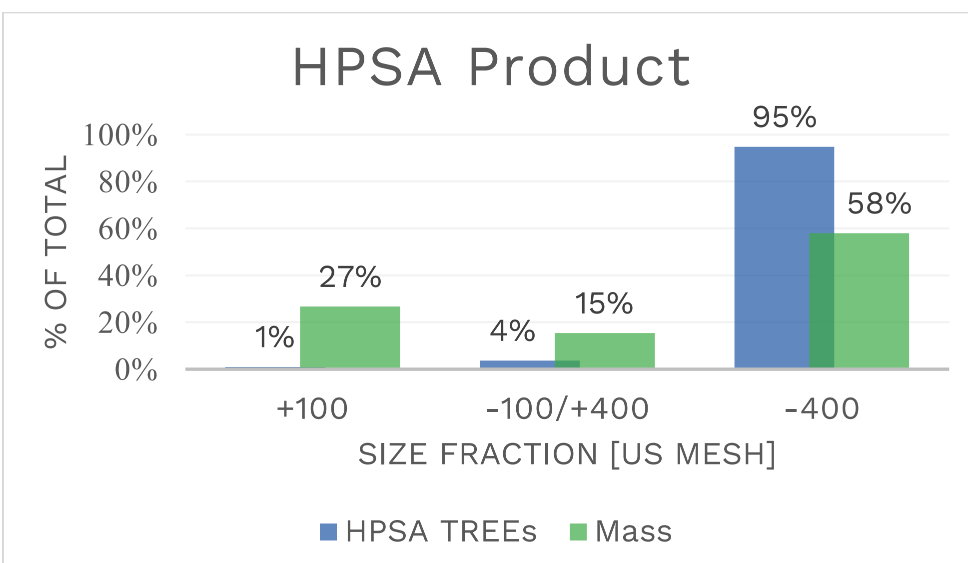


Chart 4: HPSA REE Product (2)

<u>Copper</u>

HPSA testing across multiple copper projects has demonstrated substantial improvements in selective mineral liberation and processing efficiency. In one study, HPSA concentrated 44% of copper into finer size fractions at a grade of 2.5%, significantly outperforming conventional rod milling at the same grind size, which achieved only 23% at 2.25% (2). This superior selectivity allows HPSA to effectively pre-concentrate target minerals, reducing the need for extensive downstream processing.

In another study, flotation tests conducted on scavenger tails highlighted HPSA's capabilities, with copper concentrate grades increasing from 1.15% to 2.20% and recoveries rising from 17% to 31%, despite minimal particle size reduction (2). As shown in Chart 1, the particle size of the feed and HPSA products remained relatively consistent, yet higher grades and recoveries were achieved. This improvement is attributed to the scrubbing action of HPSA, which cleans particle surfaces and helps flotation performance. Based on these results we believe HPSA can improve flotation outcomes, particularly in tailings reprocessing scenarios.

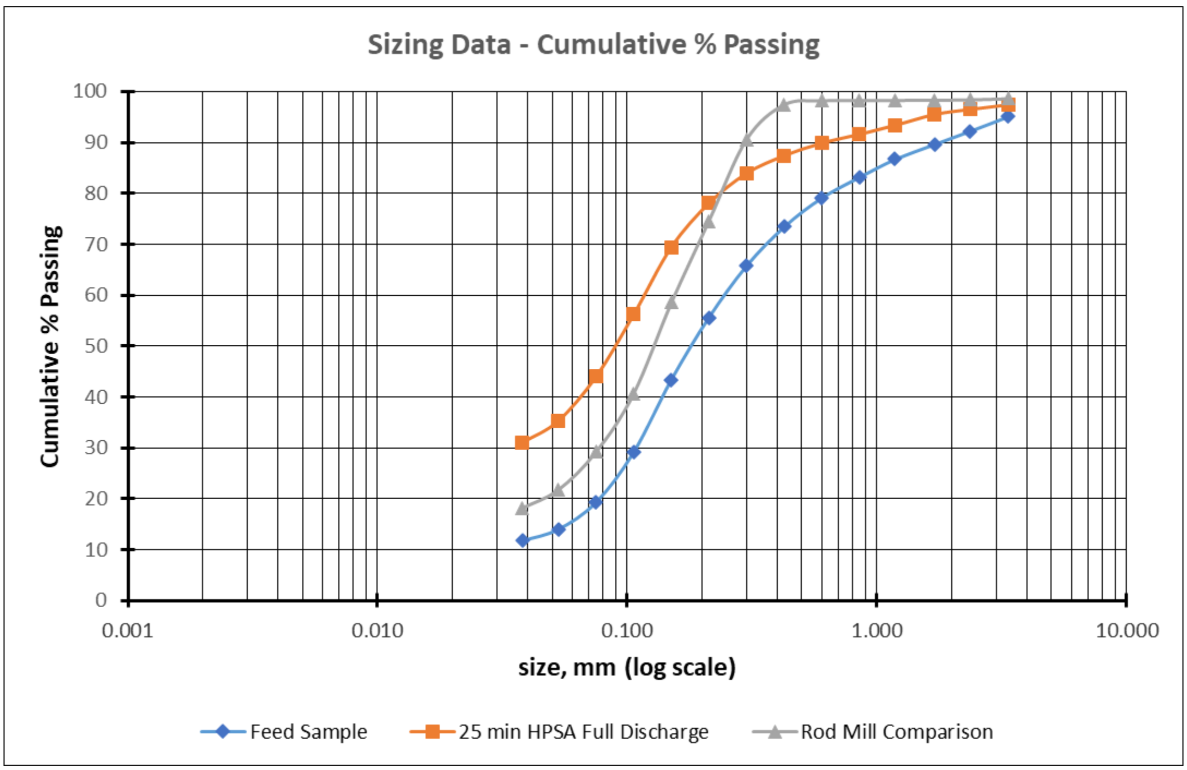


Chart 5: Particle Size Distribution of Scavenger Tails (2)

Another evaluation compared HPSA with traditional ball milling, where HPSA produced copper concentrate grades over three times higher (8.5% vs. 2.3%) while significantly lowering the mass pull to downstream circuits (4.1% vs. 13.1%). This drop in mass pull can dramatically simplify downstream operations by removing gangue material earlier in the process which would provide significant operational and economic benefits. Test results indicated larger-scale systems operating at higher solids concentrations and pump efficiencies are projected to reduce energy consumption to much less than current technologies.

Test Case	**HPSA Grade (%)**	**Conventional Grinding Grade (%)**	**HPSA Recovery (%)**	**Conventional Grinding Recovery (%)**
Selective Liberation - Copper	2.5	2.25	44	23
Scavenger Tails - Copper	2.20	1.15	31	17
Ball Mill vs. HPSA - Copper	8.5	2.3	89.5	92.3

Table 2: Comparison of Grade and Recovery Improvements with HPSA (2)

Another project where a continuous operating unit was installed following a ball mill demonstrated notable improvements in metal recoveries. The implementation of this system resulted in an increase of nickel content exceeding 2%, with peak improvements surpassing 4%. Additionally, copper recovery exhibited an uplift of over 1% (2). These findings reinforce HPSA's potential as a selective liberation technology, offering better efficiency in base metal recovery in conventional comminution circuits as a process improvement.

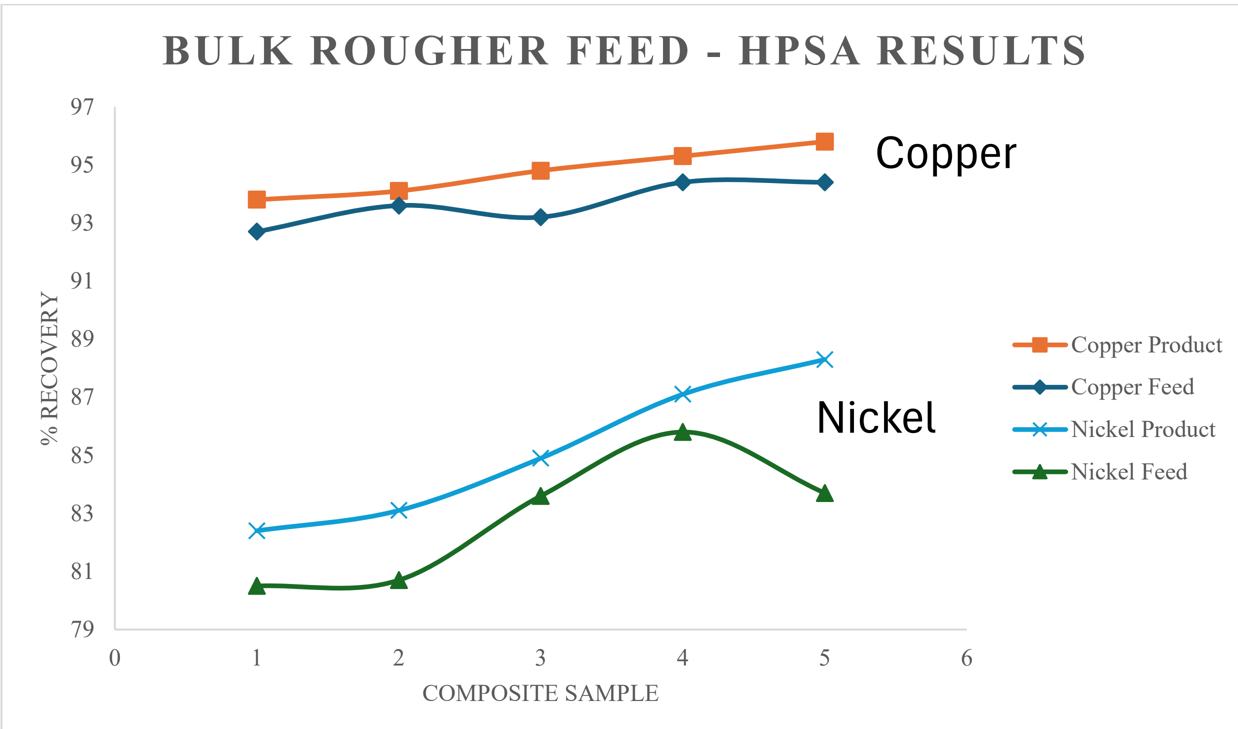


Chart 6: Nickel/Copper Feed versus Product (2)

<u>Zinc</u>

Zinc processing tests demonstrated the efficacy of HPSA in achieving comparable grade and recovery results to traditional ball milling while reducing the need for excessive fine grinding. Ball mill tests showed that at a P80 of 210 µm, nearly 93% of the zinc was liberated in the -210 µm fraction (2). In contrast, HPSA, with a coarser P80 of 1090 µm, concentrated 98% of the total zinc into the -74 µm fraction, achieving efficient liberation at larger particle sizes between zinc and gangue particles (See Table 2) (2).

Notably, only 60% of the HPSA-processed material required reduction to below 210 µm, compared to 80% for the ball mill (2). This demonstrates that 20% of the material processed by the ball mill was unnecessarily reduced to finer sizes to achieve similar recoveries (2). HPSA's selective particle fracture reduces energy consumption, minimizes overgrinding, and avoids generating excess fines, which can hinder flotation performance.

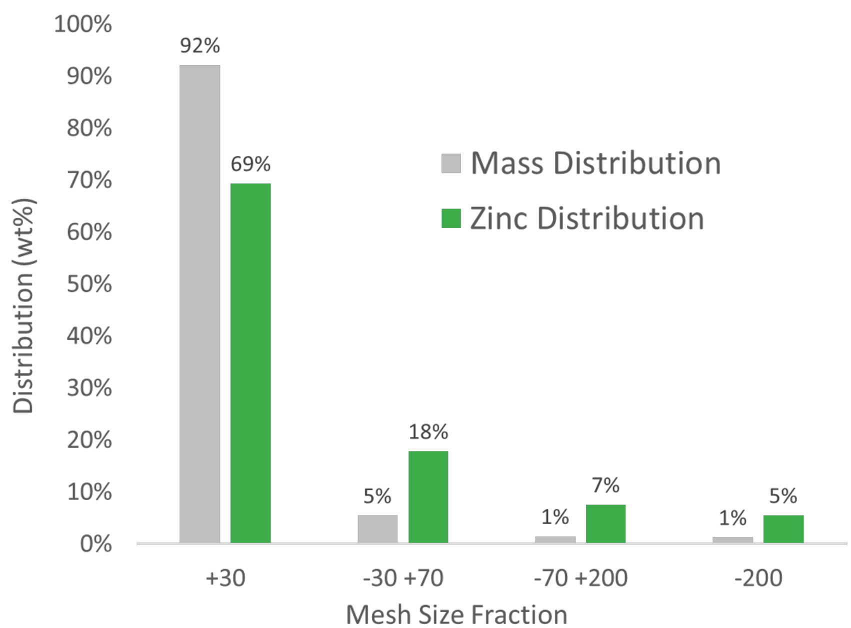


Chart 7: Feed Mass & Zinc Distribution (2)

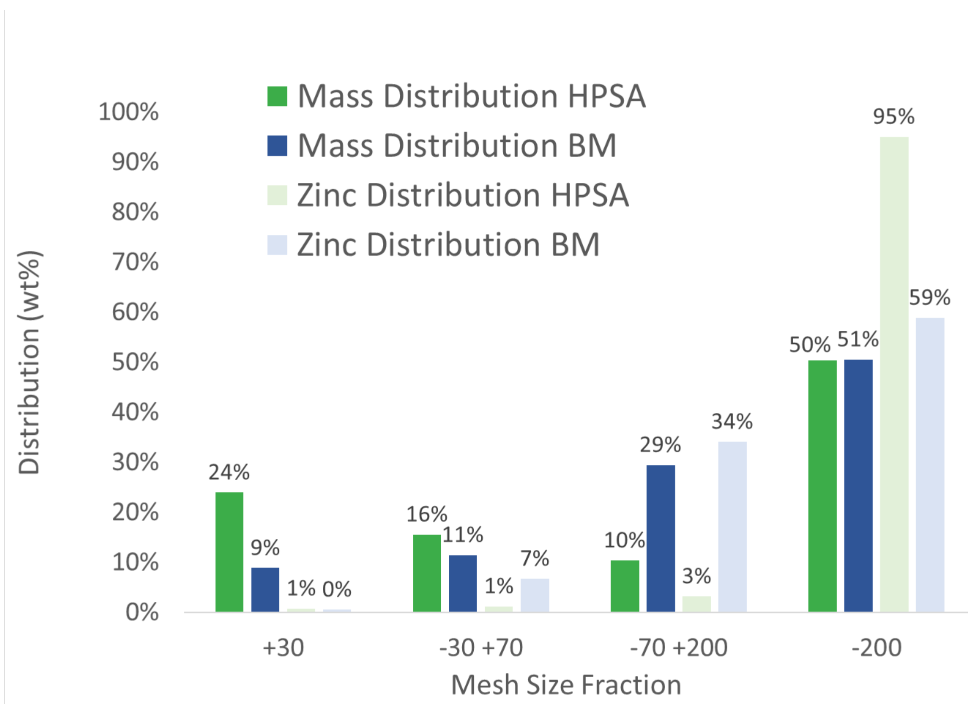


Chart 8: Ball Mill / HPSA Mass & Zinc Distribution (2)

Molybdenite

HPSA processing results for molybdenite demonstrate the technology's capability to increase molybdenum grade and recovery while reducing the insoluble content in flotation concentrates. Initial tests achieved a molybdenum grade increase from approximately 1.5% in the feed to 36% in the flotation concentrate, with a recovery rate of 85% (2). Simultaneously, the quartz content was reduced from 45% in the feed to 26% in the concentrate, reflecting the efficacy of HPSA in upgrading molybdenum and rejecting insoluble (see Table 5) (2). Despite the improvement in liberation, particle size reduction remained limited, with the P80 decreasing only slightly from 104 microns to 84 microns (see Chart 7) (2).

Like we saw in previous testing on other ore types these results are consistent in highlighting the potential for improving grade and recovery across varied mineralogical compositions. For example, flotation studies on molybdenite and associated minerals underlined the importance of HPSA for surface activation, particularly in the removal of oxide coatings, to improve molybdenum flotation performance. These insights confirm HPSA is a promising tool for optimizing regrind cleaner circuits, supporting its potential scalability and adaptability in other processing environments.

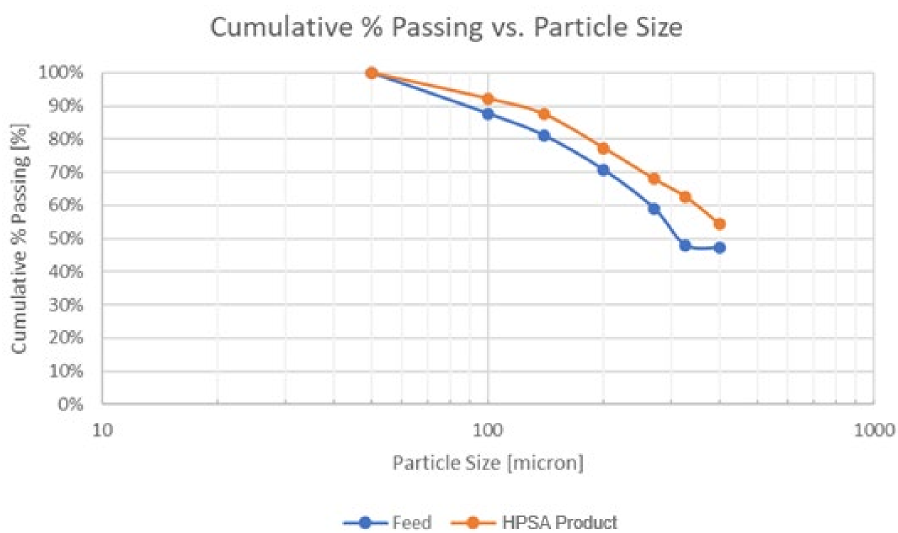


Chart 7: HPSA Molybdenum Feed Size vs Product Size (2)

Processing Parameter	Feed Value	Product Value
Molybdenum Grade (%)	1.5	36
Molybdenum Recovery (%)	-	85
Quartz Content (%)	45	26
P80 (microns)	104	84

Table 5: HPSA Molybdenum Feed vs Product Comparison (2)

Gold Tailings

Although HPSA didn't drastically reduce particle size (P80 only dropped from 145 µm to 99 µm), it still delivered a major increase in gold liberation (2). The process appears to have broken apart gold-mineral associations through surface attrition, or "sand blasting" rather than full grinding, which helped avoid overproduction of fines. Most notably, gold in the -325 mesh fraction jumped from 38% to 86%, a significant shift (2). These results indicate HPSA could be a strong fit as a pre-conditioning step in tailings reprocessing for finding value in what is currently considered waste. Further studies should assess post-HPSA flotation and leaching performance to quantify its full economic impact.

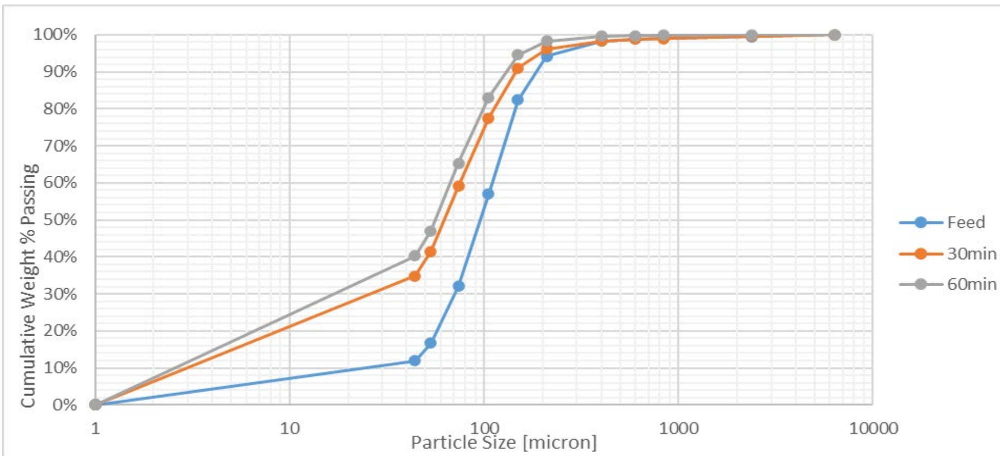
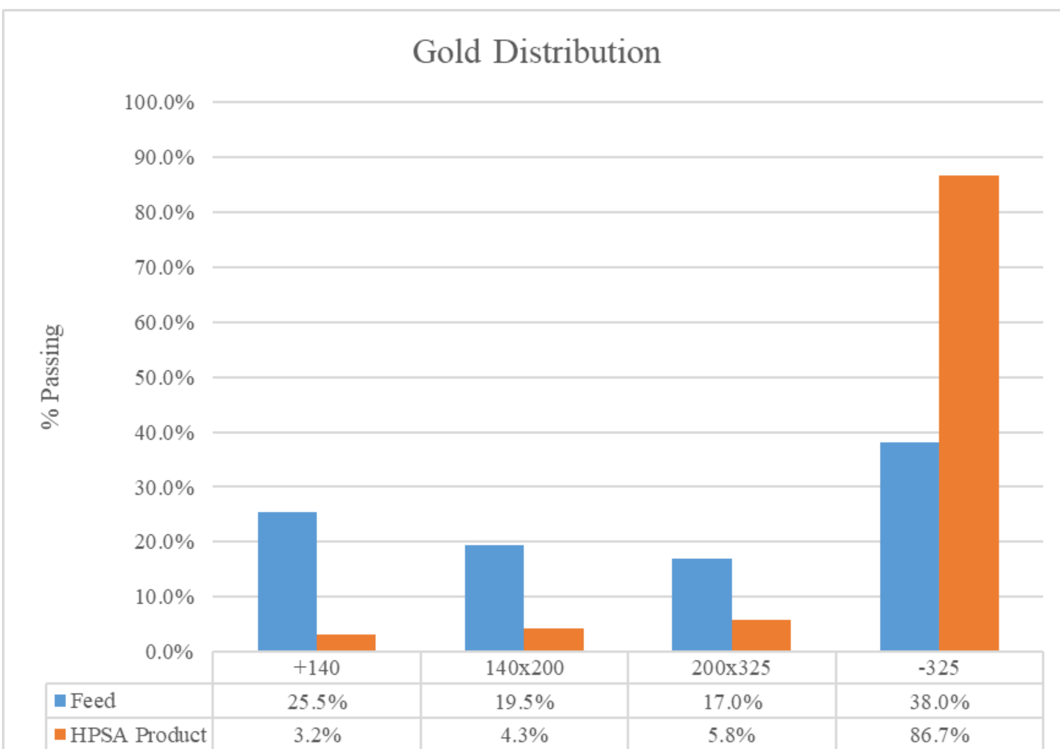


Chart 8: Gold Tailings PSD Shift (2)



	+140	140x200	200x325	-325
Feed	25.5%	19.5%	17.0%	38.0%
HPSA Product	3.2%	4.3%	5.8%	86.7%

Chart 9: Gold PSD distribution (2)

Iron Ore

Disa Technologies conducted a series of HPSA tests on a sub-200 micron hematite concentrate with the primary objective to evaluate the ability to produce a high-grade iron product exceeding 62% Fe with improved impurity rejection. Three operating conditions were tested: standard HPSA operation, a high-speed configuration, and a high-density configuration. The standard run delivered only moderate improvement, increasing Fe from 56 to 59%, prompting further optimization (2).

Under optimized HPSA conditions, the Fe content increased to 62.5% (high-speed) and 64.3% (high-density) (2). At the same time, sulfur content was reduced by over 55%, from 3700 ppm in the feed to approximately 1630–1750 ppm in the product (2). SiO_2 and Al_2O_3 were also reduced significantly, from 11.7% to ~6.4%, and from 3.3% to ~2.75%, respectively (2). When we ran these tests at the client site I was surprised by not only the improvement in Iron but also the large drop in Sulfur which could provide significant value to the industry.

While not originally designed for DRI feed preparation, the upgraded products approach DR-grade quality thresholds, making HPSA a potential fit for future green steel value chains. Its modularity, tunable parameters, and ability to treat fines make it particularly attractive for operations targeting tailings reprocessing, pellet feed upgrading, or specialty high-grade markets.

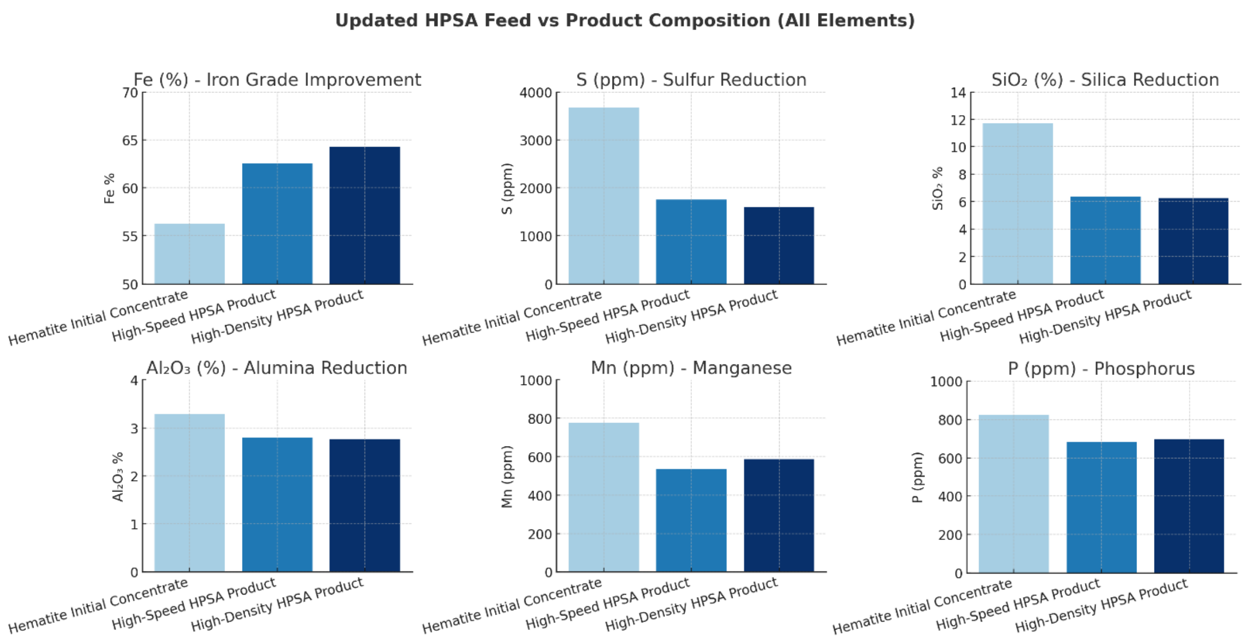


Chart 10: Hematite HPSA Results (2)

Ore Testing and Amenability

Significant HPSA testing has been conducted at various sites and operations, with the vast majority of results demonstrating its strong potential for enhancing mineral liberation and recovery processes. Despite these promising outcomes, there remains a significant range of materials and deposits that have yet to be fully evaluated. This section identifies the types of ore most amenable to HPSA technology and highlights the focus areas for future testing and development.

Critical Minerals

Critical minerals, such as cobalt, manganese, platinum, and chromium are essential for battery and energy storage technologies. These minerals require precise surface modifications to optimize their extraction, as their recovery processes depend on efficient leaching or catalysis. HPSA technology is believed to increase surface area due to the fractures along grain boundaries and create porosity due to a sandblasting effect of finer materials on coarser materials thereby improving the distribution of reactive material on ore particles. This improved reactivity ensures better interaction between ore surfaces and leaching or catalytic agents, leading to higher dissolution rates and improved recovery. For rare earth element (REE) ores, which contain complex mineral matrices, HPSA is expected to improve pore structure, surface roughness, and reactive surface exposure. This enables more efficient and targeted chemical treatments and separation processes, overcoming extraction challenges.

Refractory and Complex Ores

Refractory ores, such as nickel laterites and gold encapsulated in sulfides, are resistant to standard extraction methods due to their encapsulated or chemically complex nature. HPSA technology can change these ores by potentially increasing surface area, porosity, and mineral exposure, enabling more effective pre-treatment processes like roasting or leaching. For polymetallic ores containing copper, zinc, lead, and silver, the interlocking mineral phases complicate separation. HPSA helps can help break apart these interlocked areas allowing for mechanical or chemical methods to achieve more effective separation, improving overall recovery rates.

Industrial Minerals

Industrial minerals, such as bauxite and phosphate ores, benefit from HPSA's ability to improve processes like alumina production and fertilizer manufacturing. By including ahead of sulfuric acid phosphate digestion HPSA is able to liberate calcium and magnesium containing minerals, dropping sulfuric acid consumption per ton. Porous and metamorphic ores, including coal, shale, and uranium deposits, require efficient adsorption or leaching techniques. HPSA optimizes these processes by liberating or exposing targeted material, improving the interaction between the ore and processing fluids.

Tailings and Waste Streams

Tailings and waste streams often contain residual valuable minerals, presenting significant opportunities for reprocessing and recovery. The fine particles in these streams pose challenges due to their size and dispersion. HPSA technology potentially increases surface area, create porosity, and improves particle size control, enabling more effective recovery through leaching, adsorption, and flotation techniques. In addition to size reduction, HPSA has been shown to be effective in cleaning surface areas of tailings affected by oxidation or agglomeration. By maximizing reactive surface areas, HPSA facilitates efficient and sustainable recovery strategies that reduce both waste and environmental impacts.

HPSA's modular design makes it ideal for deployment across multiple tailings sites or within older tailings, offering flexibility for on-site processing. Additionally, as a wet process, HPSA simplifies the transport, handling, and processing of fine particles, further enhancing its suitability for tailings and waste recovery.

HPSA Challenges

HPSA technology presents a promising innovation in mineral processing, though there are areas for further development to ensure its widespread applicability. Currently, production capacity is 50 mtph, but ongoing advancements in system scalability and process optimization are aimed at addressing this challenge, paving the way for larger-scale industrial adoption. While testing is still underway for a variety of minerals and ore types, results and installations to date are encouraging, and continued research is expanding the range of compatible deposits.

HPSA is particularly well-suited for ores with bi-modal hardness, where both soft and hard components enable effective liberation. In these systems, the harder particles act as grinding media that break down the softer matrix, facilitating efficient comminution through particle-on-particle impacts. However, ores lacking this dual-mode hardness, especially ones that are uniformly coarse and hard, can present challenges for HPSA. Without a softer phase to enable internal fracturing and energy absorption during collisions, these materials tend to resist breakage, limiting the extent of particle size reduction. In these cases, HPSA may require longer residence times or higher energy inputs to achieve sufficient liberation, which can impact throughput and energy efficiency.

To address this, improvements in process design and adaptability are being explored, including optimized nozzle configurations, increased slurry velocity, and hybrid systems potentially incorporating media to increase fragmentation in resistant ores. Additionally, while very fine ores below 45 µm have presented challenges, innovations in slurry dynamics and equipment design are being developed to improve performance with finer particle sizes.

These ongoing efforts demonstrate the technology's potential to overcome current limitations and establish itself as a versatile and efficient solution for mineral processing, capable of adapting to a broader spectrum of ore types and operational conditions.

HPSA Technology Advancements

HPSA technology represents a cutting-edge innovation in mineral processing and environmental remediation. Disa Technologies, Inc., headquartered in Casper, Wyoming with a satellite facility in Denver, Colorado, is at the forefront of scaling and commercializing this technology, is venture capital backed and has raised over $35 million in private financing to date. The funding is dedicated to transitioning from pilot projects to full-scale industrial deployment.

In collaboration with Fluor Corporation, Disa is advancing and optimizing HPSA units to support diverse applications while increasing production capacity from 50 mtph to 500 mtph. The technology has already been validated by the U.S. Environmental Protection Agency (EPA), the Navajo Nation EPA, and Idaho National Lab as a proven solution for removing metals and radionuclides from legacy mine waste.

Image 3: 50 mtph HPSA Unit

Further development efforts include adding more commercial installations across different ore types to evaluate and optimize wear protection while also creating the necessary benchmarks for larger scale adoption. Additionally, Disa is introducing a continuous-operating laboratory test unit in Q1 2025, which will provide critical insights into size reduction and energy consumption compared to current batch testing. This approach will enable Disa to scale directly from lab testing to production units, bypassing the need for on-site pilots—an advantage particularly beneficial for greenfield projects.

Additionally, Disa is focused on enhancing HPSA's robustness and adaptability to withstand diverse industrial and environmental conditions, ensuring reliable 24/7/365 operation. Efforts to optimize collision chambers are also underway to maximize material liberation.

With little peer-reviewed work available on HPSA, Disa is pursuing publication partnerships to formalize testing protocols and benchmark outcomes across diverse ore types.

Conclusion

In most of the lab and field trials we have conducted, HPSA has proven itself as a possible serious alternative to traditional grinding. By using the power of high-pressure particle collisions, HPSA achieves efficient size reduction, selective mineral liberation, and impurity separation, outperforming conventional grinding methods in energy efficiency and process outcomes. Test results across diverse materials, including uranium, vanadium, copper, graphite, lithium, rare earth elements, and phosphate, consistently highlight HPSA's capability to improve recovery rates, increase grades, and reduce operational costs.

The versatility of HPSA extends beyond mineral processing to applications such as tailings reprocessing, industrial water treatment, and legacy site remediation, offering sustainable solutions to critical industry challenges. Its modular design and adaptability make it ideal for both large-scale industrial operations and localized processing needs. Furthermore, ongoing advancements—such as higher-capacity units, continuous operation models, and optimized collision chambers—demonstrate the technology's potential for further scalability and efficiency improvements.

From my perspective, having deployed HPSA in both pilot and continuous applications, I'm convinced this technology can reshape how we think about mineral liberation — especially as global supply chains scramble to secure clean, efficient sources of lithium, cobalt, and rare earths.

Disclaimer

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